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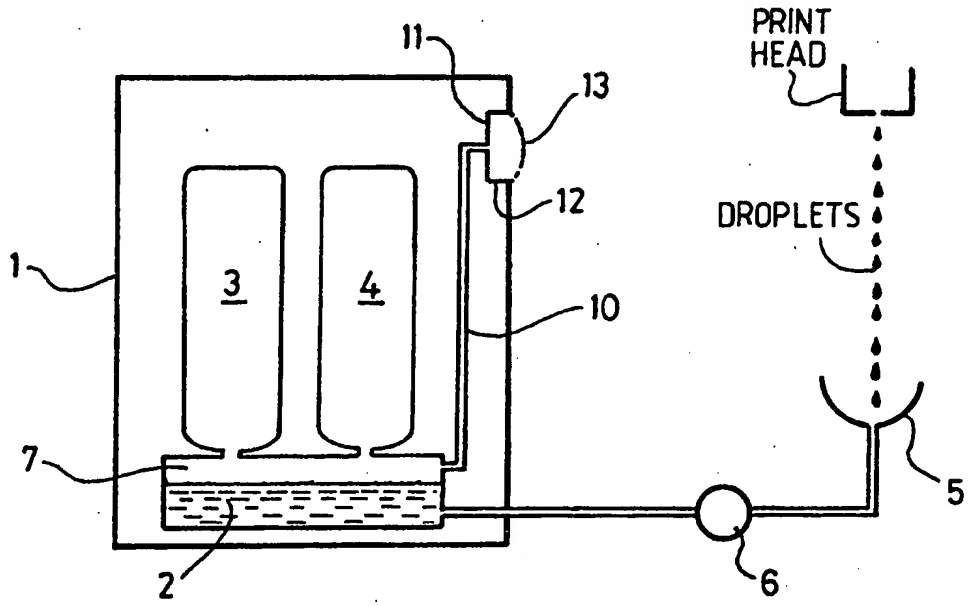
(54) Title: AIR VENT SYSTEM WITH SOLVENT VAPOUR FILTER FOR AN INK RESERVOIR



(57) Abstract

The present invention relates to an ink jet printer comprising a reservoir (2) which is to contain a fluid and in the headspace (7) above the fluid a solvent vapour, from which reservoir air containing the solvent vapour is to be vented to the environment; characterised in that the solvent vapour laden air outlet from the reservoir is connected to a diffusion device (12) which is adapted to reduce the concentration of solvent vapour in the air immediately adjacent to the discharge exit to the device to below the level of that entering the device.

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AIR VENT SYSTEM WITH SOLVENT VAPOUR FILTER FOR AN INK RESERVOIR

The present invention relates to a device, notably to an ink jet printer having a means for venting solvent laden vapour from the ink reservoir.

BACKGROUND TO THE INVENTION:

In many forms of ink jet printer, ink is held in a reservoir from which it is pumped to the nozzle orifices for ejection as discrete droplets. Often, the ink is re-cycled from the print head, for example from the gutter in which ink droplets which are not to be printed are caught in a continuous ink jet printer. The re-cycling ink is often accompanied by an air stream which is laden with solvent vapour, notably where the mixture of ink and solvent vapour from the collection gutter is recycled using a venturi pump.

It is therefore common practice to vent the head space in the ink reservoir to allow the recycled air to escape to the environment. This practice has been widespread in the printing industry.

Surprisingly, we have found that the vented air from an ink jet printer may contain sufficient solvent vapours for it to be a fire or safety hazard in itself; and we have devised a device through which the solvent-laden air may be vented from the ink reservoir which achieves a significant reduction in the fire or other hazard posed by the vented air.

SUMMARY OF THE INVENTION:

Accordingly, the present invention provides an ink jet printer comprising a reservoir which is to contain a fluid and in the headspace above the fluid a solvent vapour, from which reservoir air containing the solvent vapour is to be vented to the environment; characterised in that the solvent vapour laden

air outlet from the reservoir is connected to a diffusion device which is adapted to reduce the concentration of solvent vapour in the air immediately adjacent to the discharge exit to the device to below the level of that entering the device.

Preferably, the ink jet printer is continuous ink jet printer in which an ink/solvent laden air stream is to be recycled from a gutter in which ink droplets which are not to be printed are collected and are recycled by means of a venturi or other pump to the ink reservoir. The fluid ink remains in the reservoir for re-use but the solvent vapours and air collect in the headspace above the fluid in the reservoir and must be vented. For convenience, the invention will be described in terms of such a continuous ink jet printer.

The solvent laden air is vented from the headspace of the ink reservoir in any suitable manner, for example by means of a plastic, metal or similar vent tube extending from the top of the reservoir. The vent tube may be provided with means, such as a Peltier effect cooler, or cooling radial fins upon a length of the vent tube, by which at least part of the solvent values in the air vented from the reservoir can be condensed out and returned to the reservoir. If desired, the vent tube may incorporate a fluid trap or other means for reducing the risk of overflow of ink and/or condensed solvent through the vent pipe directly to the environment.

Hitherto, the vent pipe has discharged directly to the environment, for example through a side wall or base wall of the casing housing the ink system, or has vented into the ink or solvent bottle feeding the ink reservoir, which bottle in turn has then been vented into the interior of the casing or to the environment. The present invention can be applied to the vent from the reservoir or the vent from either of both the ink or solvent bottles. However, for convenience the invention will be described in terms of the vent from the ink reservoir for the ink flow system of the ink jet printer and the term

reservoir will be used herein to denote in general any vessel which contains a fluid from which a solvent laden air stream or vapour is to be vented to the environment.

In the present invention, the reservoir is vented to the environment and it may be desired to vent the solvent and/or ink bottles to the environment as well through a single diffusion device according to the invention, either through T or other connection with the vent pipe from the reservoir to a common diffusion device; or via a separate diffusion device serving each reservoir or bottle to be vented. For convenience, the invention will be described hereinafter in terms of venting a single reservoir through a single vent pipe serving a single diffusion device.

The solvent laden air in the headspace above the ink level in the ink reservoir is vented via a suitable plastic, metal or other material vent pipe, which typically extends from adjacent the top of the reservoir, under the pressure caused by the incoming air stream from the venturi or other pump circulating the re-cycled ink to the reservoir. If desired, a separate stream of air may be fed to the headspace in the reservoir to assist transport of the solvent vapours through the vent pipe.

The vent pipe is connected to the diffusion device, which is preferably mounted on a side wall of the housing containing the reservoir to be vented so that external air flows over the outlet to the device so as to aid dispersion of the solvent vapours into the surrounding air and thus reduce the concentration of the solvent vapours immediately adjacent the outlet to the device yet further. However, the device of the invention may be located in the base or top wall of the ink jet printer housing.

The diffusion device of the invention serves to reduce the concentration of the solvent vapours in the environment

immediately adjacent the outlet to the device by causing the solvent laden air to be discharged over a greater area than the cross-sectional area of the inlet to the device and/or by causing the solvent vapour laden air stream to be discharged in one or more streams which have a slower linear flow rate than at the inlet to the diffusion device, eg. from 0.1 to 25 % of the linear flow rate of the air stream at the inlet; and will thus be more rapidly diluted by external air to below fire and/or health hazard levels immediately adjacent the outlet to the diffusion device.

Thus, in one form of diffusion device, the solvent laden air stream follows a tortuous path during which it becomes progressively diluted with external air drawn into the path. Alternatively, the cross-sectional area of the outlet to the device is larger, for example from 5 to 400, for example 200 to 300, times larger, than the cross-sectional area of the inlet to the device so that the solvent laden air is discharged over a large area into the environment and thus achieves the desired dilution of the solvent as the air discharges from the device and also issues at a slower linear flow rate than at the inlet to the device. Preferably, such an expansion device incorporates a transition chamber which is located between the inlet and outlet so that the air stream can expand and reduce its linear flow rate within the chamber prior to its discharge through an open face of the chamber. If desired, such an expansion chamber can be provided with an external air inlet to achieve further dilution of the solvent vapours before they are discharged from the device. Such external air can be supplied by a suitable pump means to provide a positive flow of external air through the device if desired.

In a particularly preferred form of diffusion device, the solvent laden air stream is caused to follow a tortuous path through a glass fibre or metal mesh or gauze pad, a foamed plastic pad, a fritted ceramic disc or pad or a series of baffles within the chamber and the outlet to the device is

provided by an open face to the chamber having a fine mesh or gauze wall through which the air issues as a multiplicity of fine slow moving streams. Such a preferred form of the device ensures that the flow of air is spread across substantially the whole of the larger discharge face and is slowed down during its travel through the device. The issuing multiplicity of solvent laden air streams are thus rapidly diluted when they discharge into the environment.

Alternatively, the device can comprise a conduit or the like from which the solvent laden air stream is discharged at a number of discharge outlet spaced apart along the length of the conduit so that the solvent vapour laden air stream is discharged over a greater area than the cross-sectional area of the inlet to the conduit and the local concentration of solvent vapours in the environment around each discharge outlet is rapidly diluted to below any hazard level.

The invention provides a simple and effective means by which air containing solvent vapours can be discharged directly to the environment with reduced risk of the safe concentration of the solvent vapour in the environment being exceeded. The diffusion device for present use can be readily inserted into the outlet of the air vent line of a conventional ink jet printer as a retro-fit component, enabling existing printers to be readily modified so as to meet safety and fire requirements without the need for major modification of the printer.

DESCRIPTION OF THE DRAWINGS:

A device of the invention will now be described by way of illustration with respect to the accompanying drawings, in which Figure 1 is a vertical side cross-section through an ink reservoir and air vent system incorporating a diffusion device as required in the present invention; Figure 2 is a vertical face on cross-section of an alternative form of the device of Figure 1; and Figures 3 and 4 are vertical side cross-sections

through alternative forms of the device of Figure 1.

DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION:

An ink jet printer comprises a housing 1 containing an ink reservoir 2 fed with make up solvent or ink from separate bottles 3 and 4. Ink is fed under pressure by a pump (not shown) from the reservoir 2 to the print head, from which it issues as a stream of droplets. These are either printed on a substrate (not shown) and the position at which the droplets are printed is selected by known droplet charging and deflection means (not shown) or are not printed and are directed into a collection gutter 5. The ink which is collected by gutter 5 is recycled by a pump 6 to reservoir 2. Due to the suction of the pump on the open topped gutter, air and solvent vapours from around the gutter are drawn into pump 6 and recycled with the ink to reservoir 2. Where the pump 6 is a venturi pump driven by excess ink driven by the pump feeding ink from the reservoir to the print head, further solvent vapours may be formed within pump 6 and will be recycled to reservoir 2.

The solvent laden air/ink steam is recycled from pump 6 into the reservoir 2. In order to prevent the build up of excessive air pressure with the reservoir 2, the head space 7 above the ink level in the reservoir 2 is vented via a vent pipe 10. The vent pipe is connected to the inlet 11 of an expansion chamber 12 mounted in a side wall of the housing 1. The chamber is conveniently of a cylindrical shape as shown, with one circular face formed from a fine gauze or metal mesh 13. The diameter of the outlet face 13 is from 200 to 300 times the diameter of the bore of the inlet 11. Preferably, the interior of the chamber 12 is filled with a gauze or porous ceramic pad 14 which ensures that the air entering the chamber follows a tortuous path within the chamber and becomes diffused throughout the chamber so that it issues substantially uniformly over the whole of the area of the face of mesh 13.

If desired, a supply of diluent air can be fed to the rear face of chamber 12 by any suitable means to assist dilution of the solvent vapour levels within the chamber 12.

As shown in Figure 2, the interior of the chamber 12 may be subdivided by annular and/or other baffles 20 which cause the air to follow a tortuous path within the chamber to achieve the uniform outflow of the air over mesh face 13.

In place of a cylindrical chamber as shown in Figure 1, the chamber can be of a conical cross-section as shown in Figure 3, preferably with a gauze or similar infill pad 14 to aid spreading of the solvent laden air stream from the narrow inlet 11 to the broad outlet face 13. In the alternative shown in Figure 4, the air is vented along the length of a pipe 30 via a series of axial ports 31 which ensure that the solvent vapours are rapidly diluted by the external air immediately adjacent to each outlet 31.

CLAIMS:

1. An ink jet printer comprising a reservoir which is to contain a fluid and in the headspace above the fluid a solvent vapour, from which reservoir air containing the solvent vapour is to be vented to the environment; characterised in that the solvent vapour laden air outlet from the reservoir is connected to a diffusion device which is adapted to reduce the concentration of solvent vapour in the air immediately adjacent to the discharge exit to the device to below the level of that entering the device.

2. An ink jet printer as claimed in claim 1, characterised in that the diffusion device has one or more outlets which have a cross-sectional area which is from 5 to 400 times the cross-sectional area of the inlet to the device.

3. An ink jet printer as claimed in either of claims 1 or 2, characterised in that the diffusion device is adapted to discharge the solvent laden air in one or more streams at a linear velocity which is from 0.1 to 25% of the linear velocity of the air stream at the inlet to the diffusion device.

4. An ink jet printer as claimed in any one of the preceding claims, characterised in that the diffusion device comprises an expansion chamber for the solvent laden air stream.

5. An ink jet printer as claimed in any one of the preceding claims, characterised in that the diffusion device comprises a glass fibre or metal mesh or gauze pad, a foamed plastic pad, a fritted ceramic disc or pad or a series of baffles within a chamber through which the solvent laden air stream is adapted to follow a tortuous path between the inlet to the chamber; and the outlet to the device is provided by an open face to the chamber having a fine mesh or gauze wall through which the solvent laden air is adapted to issue as a multiplicity of fine slow moving streams.

6. An ink jet printer as claimed in claim 1, characterised in that the diffusion device comprises an outlet pipe having a multiplicity of outlets along its length.

7. An ink jet printer as claimed in claim 1, substantially as hereinbefore described with respect to and as shown in any one of the accompanying drawings.

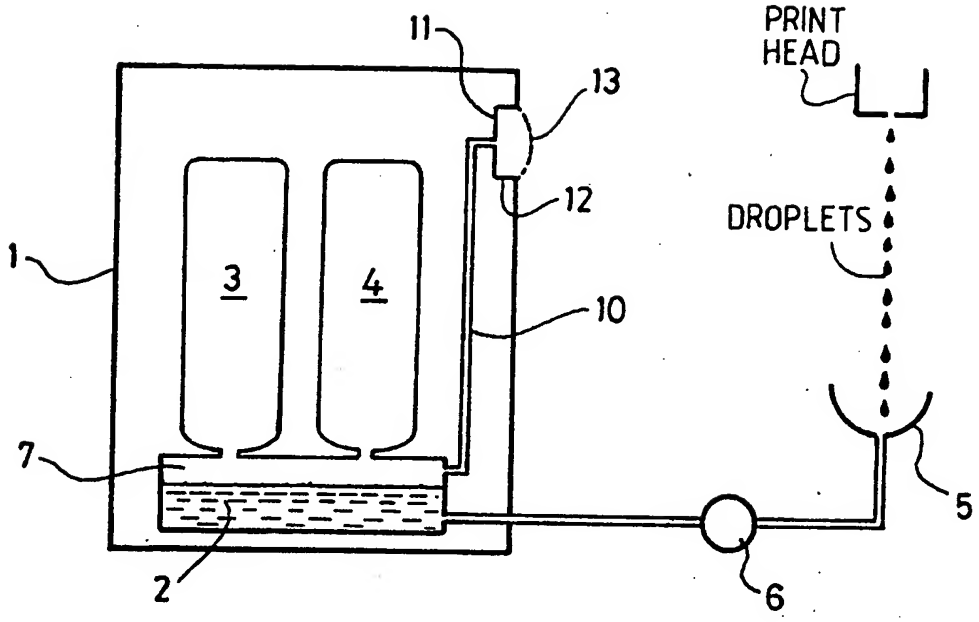

Fig. 1

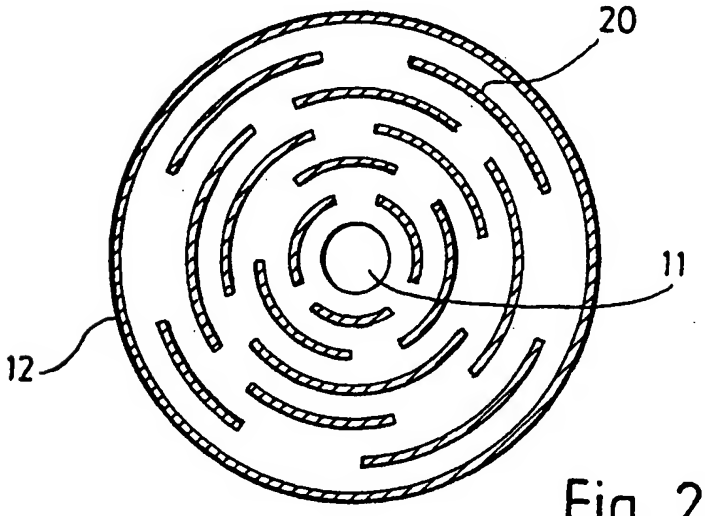

Fig. 2

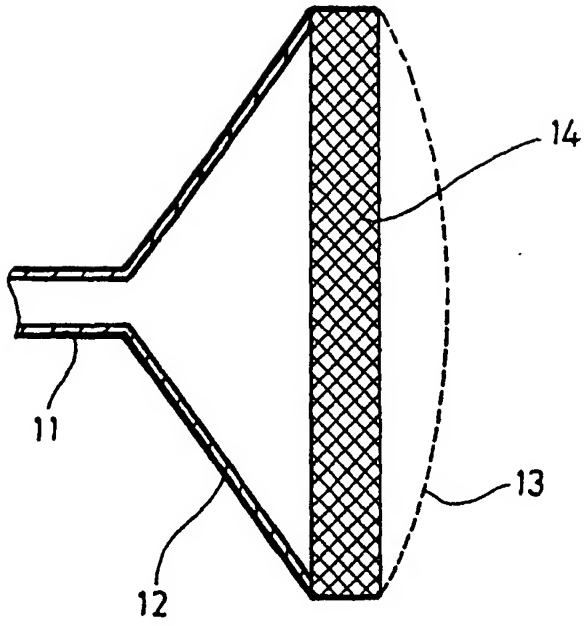

Fig. 3

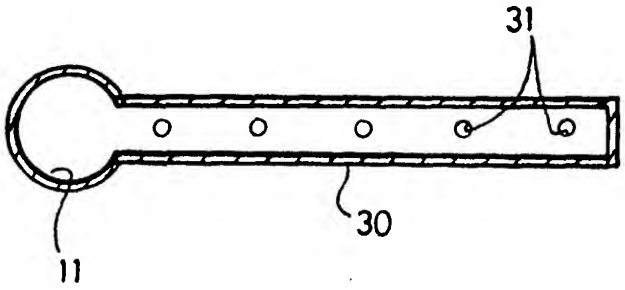

Fig. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 93/02029

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 B41J2/18 B41J2/175

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 B41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 419 677 (CANON K.K.) 6 December 1983 see column 3, line 65 - column 4, line 15; figure 3	1
A	IBM TECHNICAL DISCLOSURE BULLETIN vol. 18, no. 4 , September 1975 pages 1108 - 1109 PORTIG AND SENDELWECK 'HYDRAULIC FILTER SYSTEM'	1
A	IBM TECHNICAL DISCLOSURE BULLETIN vol. 25, no. 3A , August 1982 pages 946 - 947 DRISCOLL AND GREGORY 'evaporation recovery system'	1

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[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	PATENT ABSTRACTS OF JAPAN vol. 6, no. 36 (M-115)(914) 5 March 1982 & JP,A,56 151 570 (CANON K.K.) 24 November 1981 see abstract	2
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 519 (M-895)(3867) 20 November 1989 & JP,A,01 209 147 (MATSUSHITA) 22 August 1989 see abstract	1
A	US,A,4 824 487 (HEFFERNAN) 25 April 1989 see abstract; figure 1	1

1

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No
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		JP-B-	61060773	22-12-86
		DE-A-	3039166	07-05-81
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